

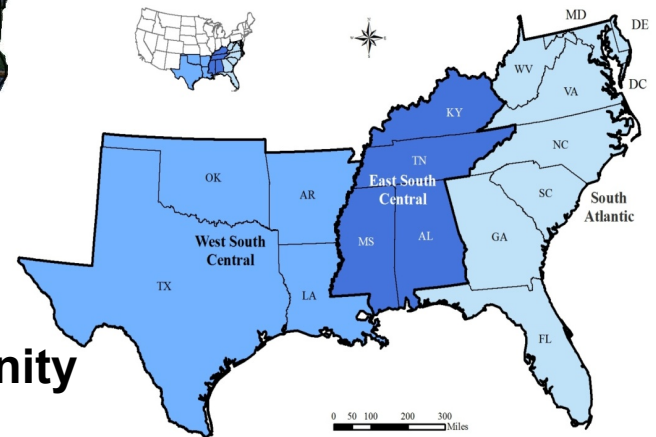
Energy and Climate Change



From the globe and nation...



...to the region and community



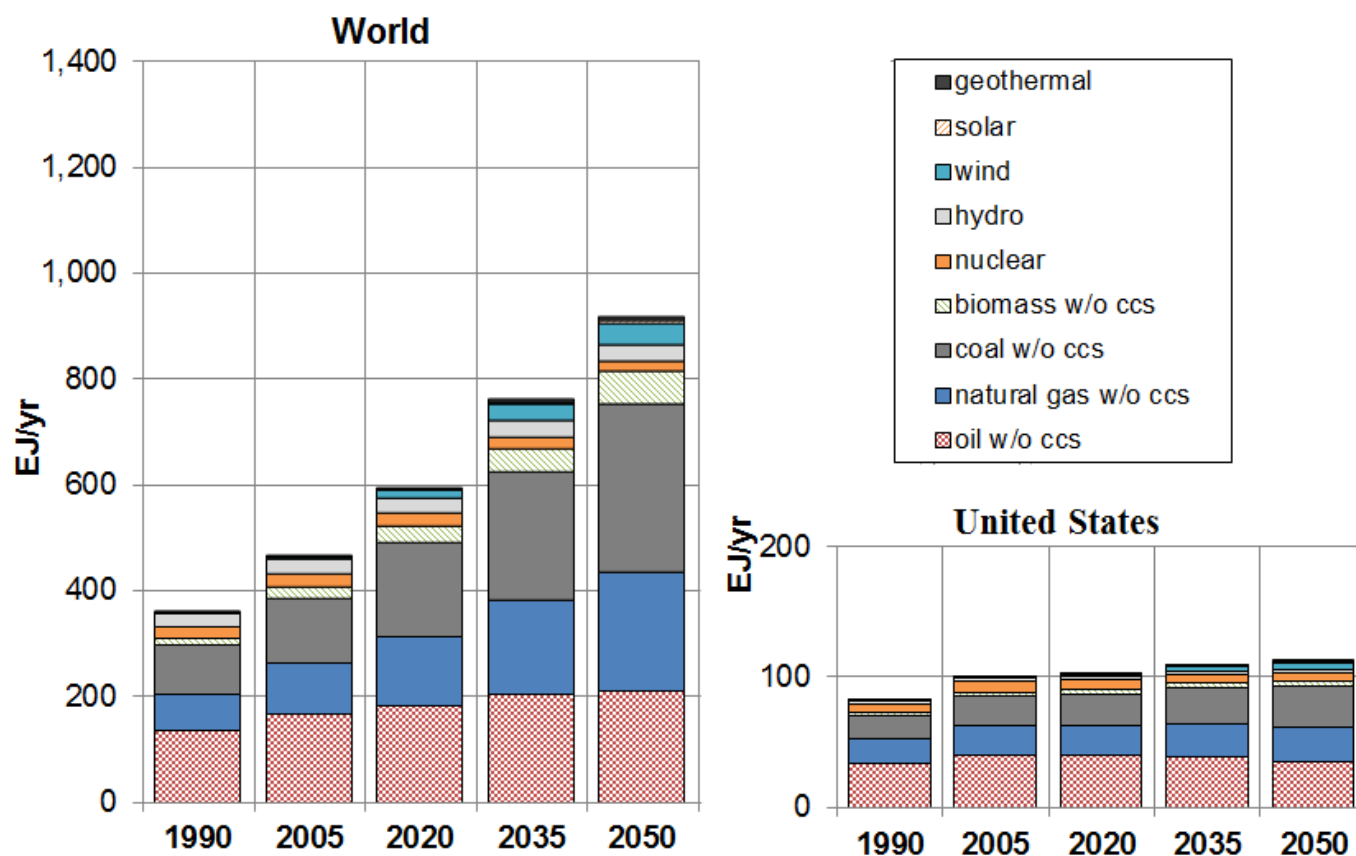
Dr. Marilyn A. Brown
Professor of Energy Policy
Georgia Institute of Technology

Richard Smyser Lecture Series
American Museum of Science & Energy
June 26, 2014

Emerging Economies will Increasingly Steer Global Energy Markets

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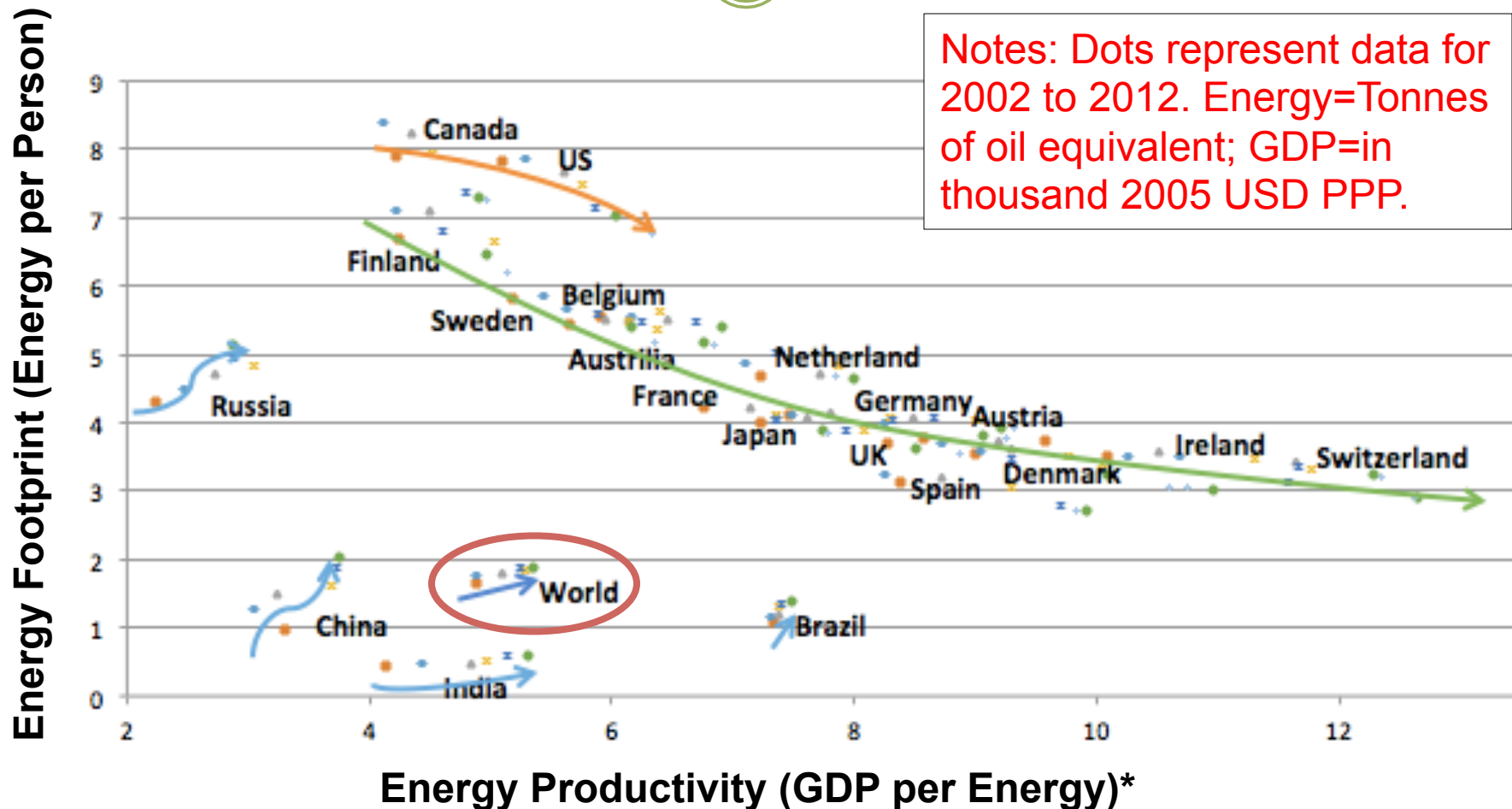
Global energy demand will rise by one-third over the next 25 years, driven by rising living standards in China, India & the Middle East.



Source: International Energy Agency. 2012. *World Energy Outlook*.

Energy Productivity is Increasing Globally, but So are Energy (per capita) Footprints

3

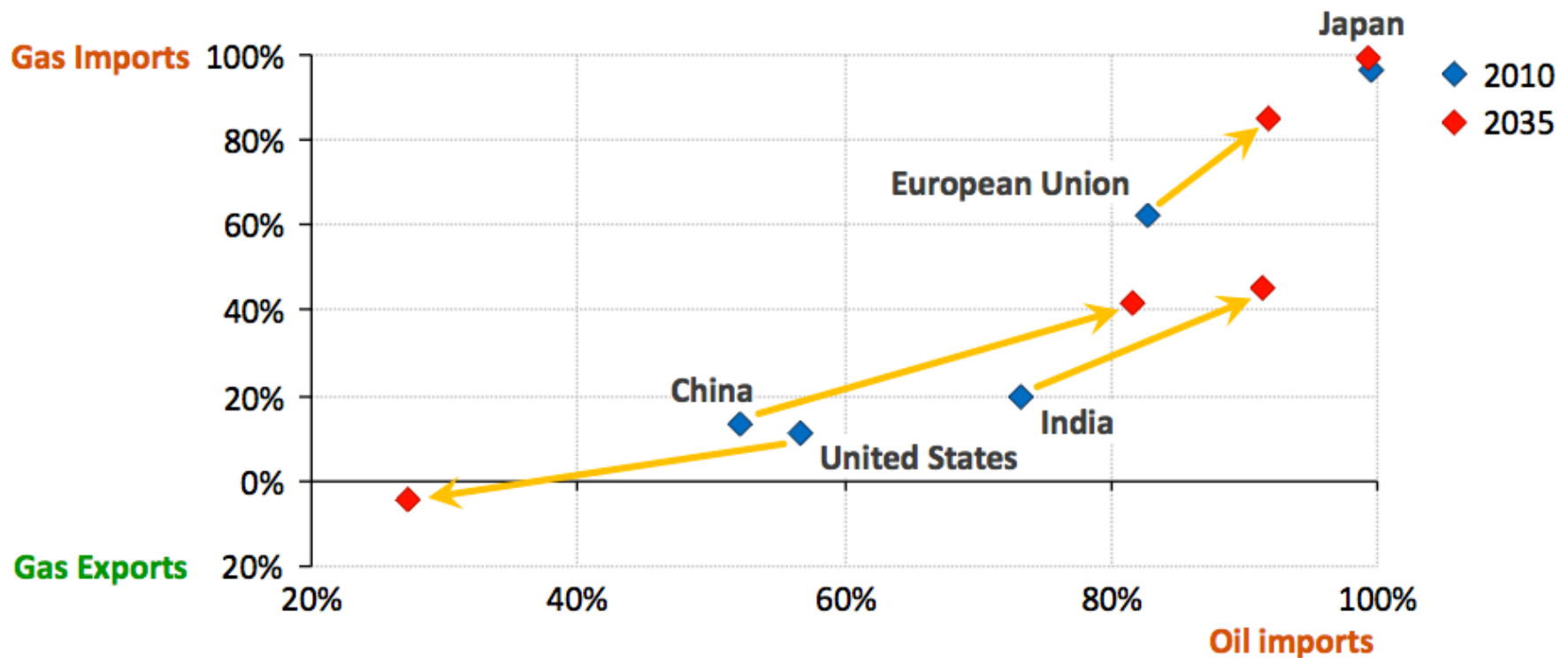


Source: Brown, Marilyn A. 2014. "Enhancing Efficiency and Renewables With Smart Grid Technologies and Policies," *Futures: The Journal of Policy, Planning and Futures Studies*.

How are Regions of the World Going to Satisfy this Growing Demand for Energy?

4

- Net oil and gas import dependency in selected countries.



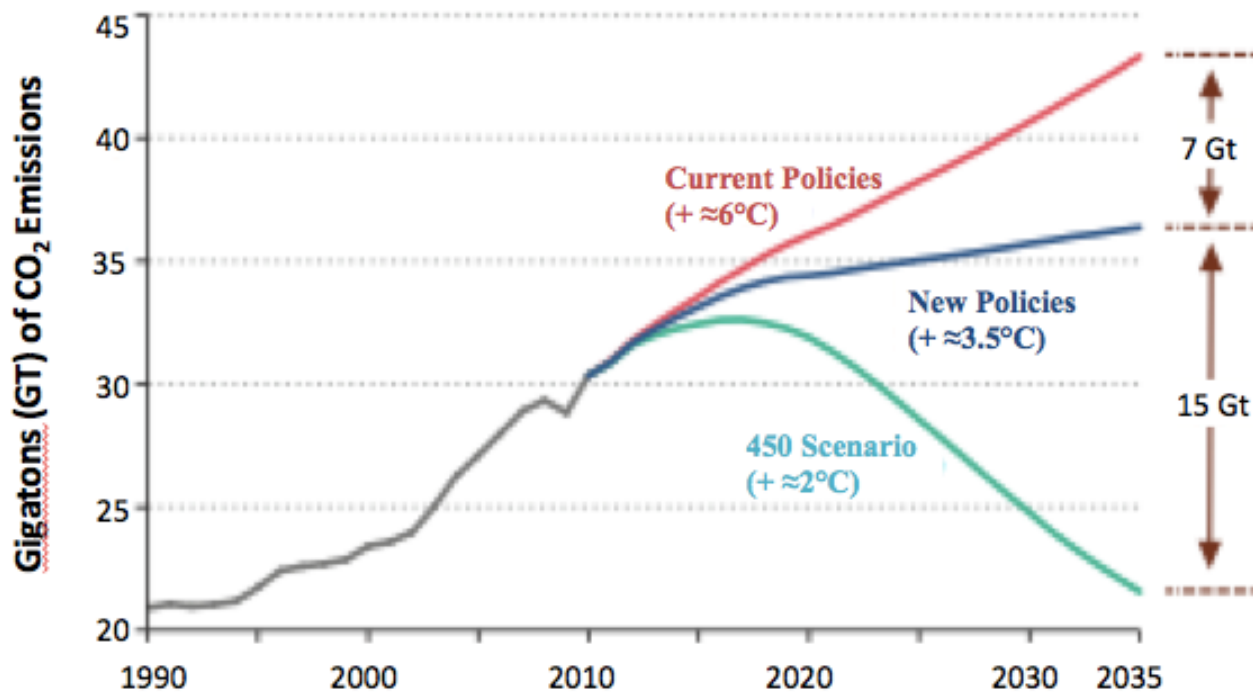
Will the U.S. bonanza of affordable natural gas be a bridge or a barrier to a clean energy future?

Source: International Energy Agency. 2012. *World Energy Outlook*.

The Door is Closing on 450 ppm CO₂ (or a 2°C Rise in Global Temperatures)

5

Four-fifths of the total energy-related CO₂ emissions of the 450 Scenario are already “locked-in” by existing capital stock



World Energy-Related CO₂ Emissions by Scenario

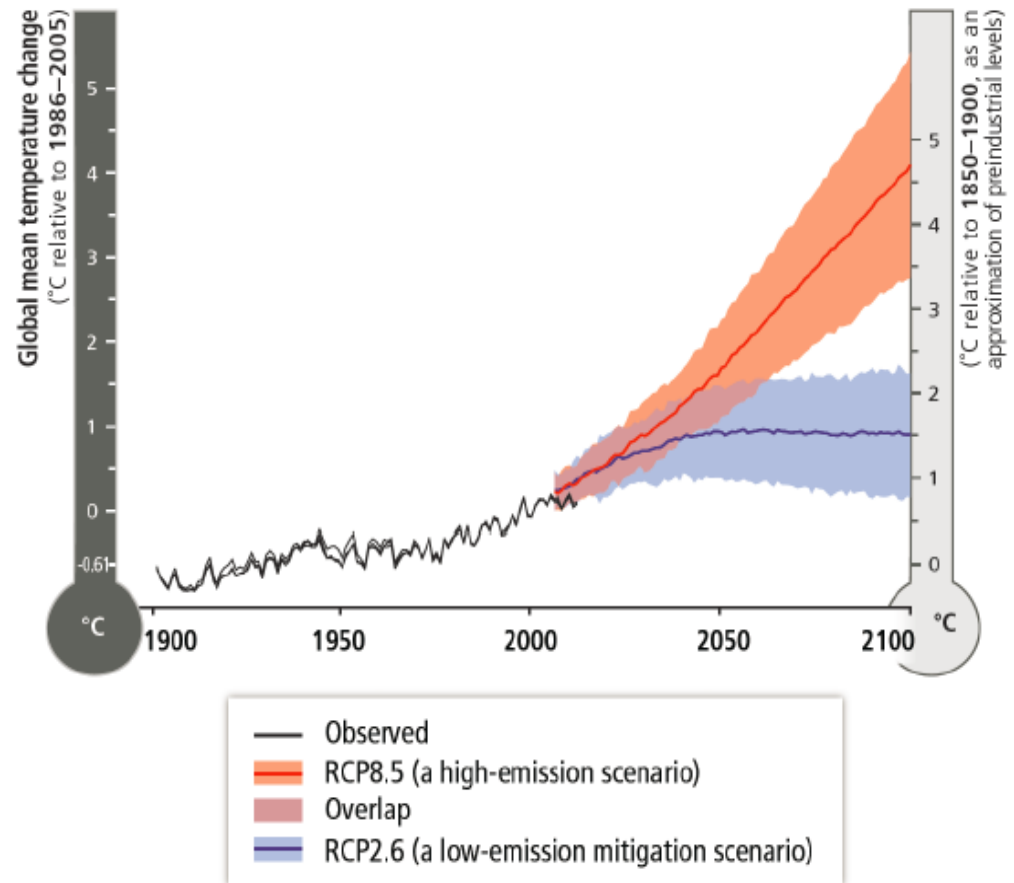
Source: International Energy Agency. 2011. *World Energy Outlook*.

Global Surface Temperature Change

6

Global mean temperatures could rise by 1.5°C (with a low-emission scenario) to 4.5°C (with a high-emission scenario) by the end of the century relative to 1850-1900.

RCP = Representative Concentration Pathway (+ total radiative forcing in 2100 relative to 1750)

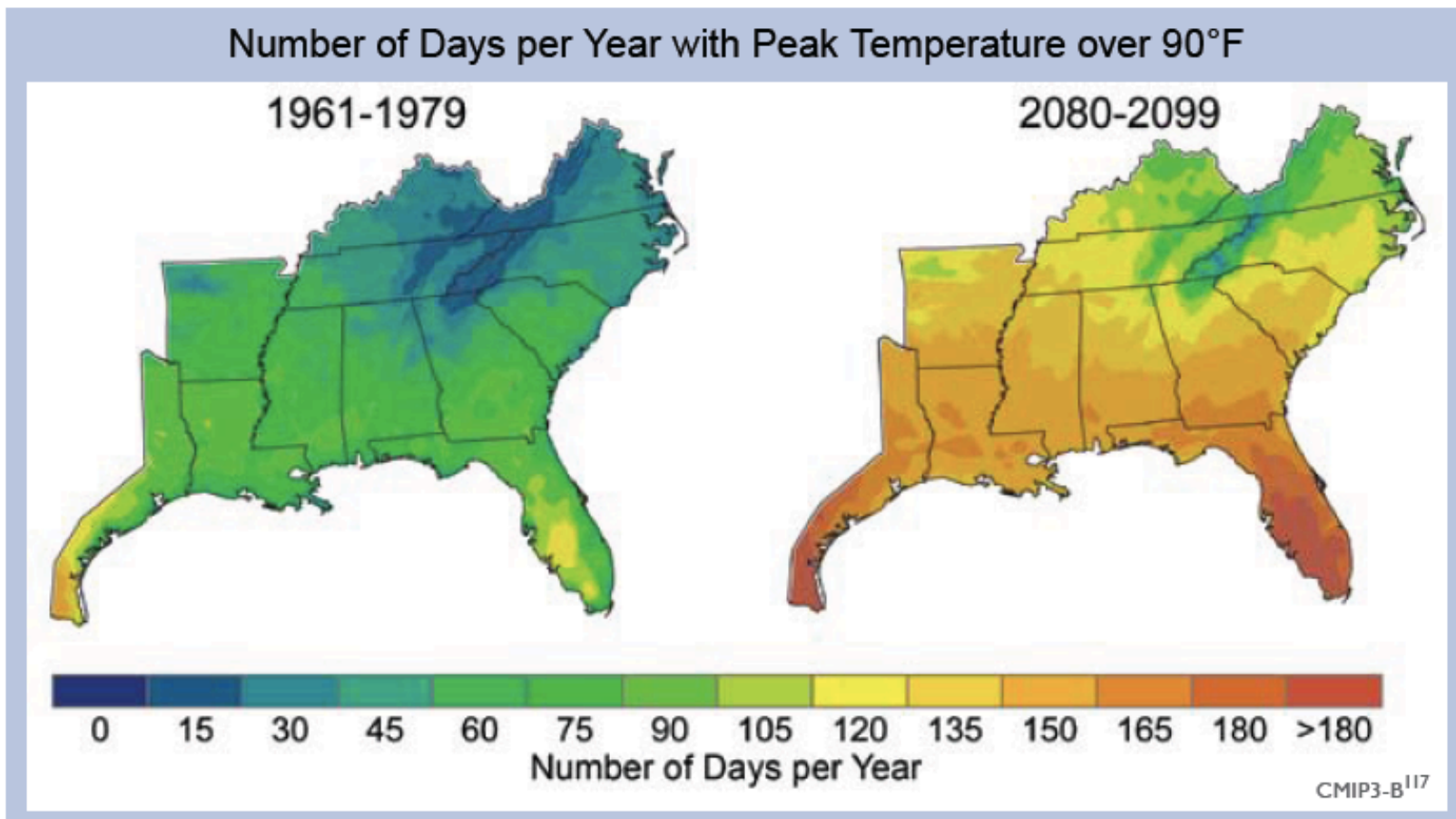


Source: Intergovernmental Panel on Climate Change (IPCC). 2013. *Climate Change 2013: The Physical Science Basis*. "Summary for Policymakers".

In the Southeast, Annual Average Temperature Has Risen about 2°F since 1970

7

Accelerated warming is forecast for the Southeast.



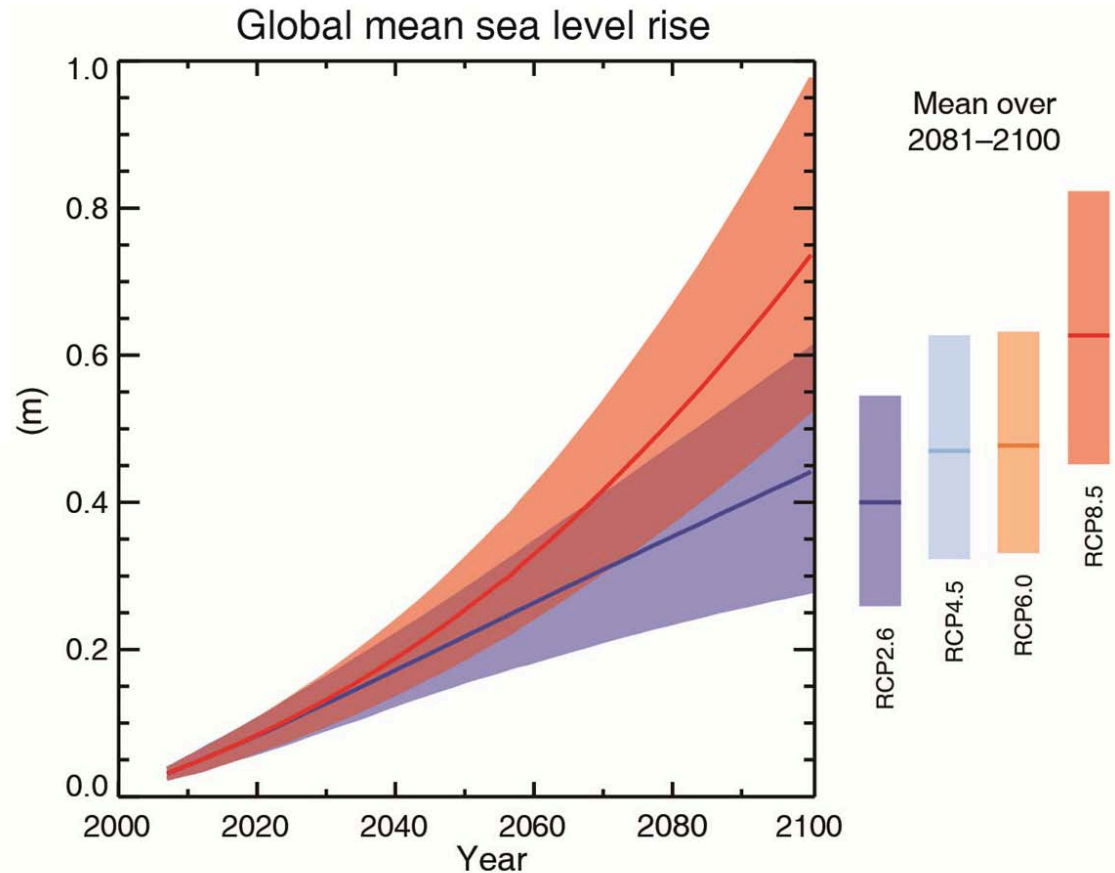
Source: <http://www.globalchange.gov/images/cir/pdf/southeast.pdf>

Sea Level rise

7

Sea level could rise by 0.4 meters (with a low-emission scenario) to 0.7 meters (with a high-emission scenario) by the end of the century relative to 2000.

The rate of global mean sea level rise has been increasing since the early 20th century.



Source: Intergovernmental Panel on Climate Change (IPCC). 2013. *Climate Change 2013: The Physical Science Basis*. “Summary for Policymakers”.

Increased Flooding is Forecast

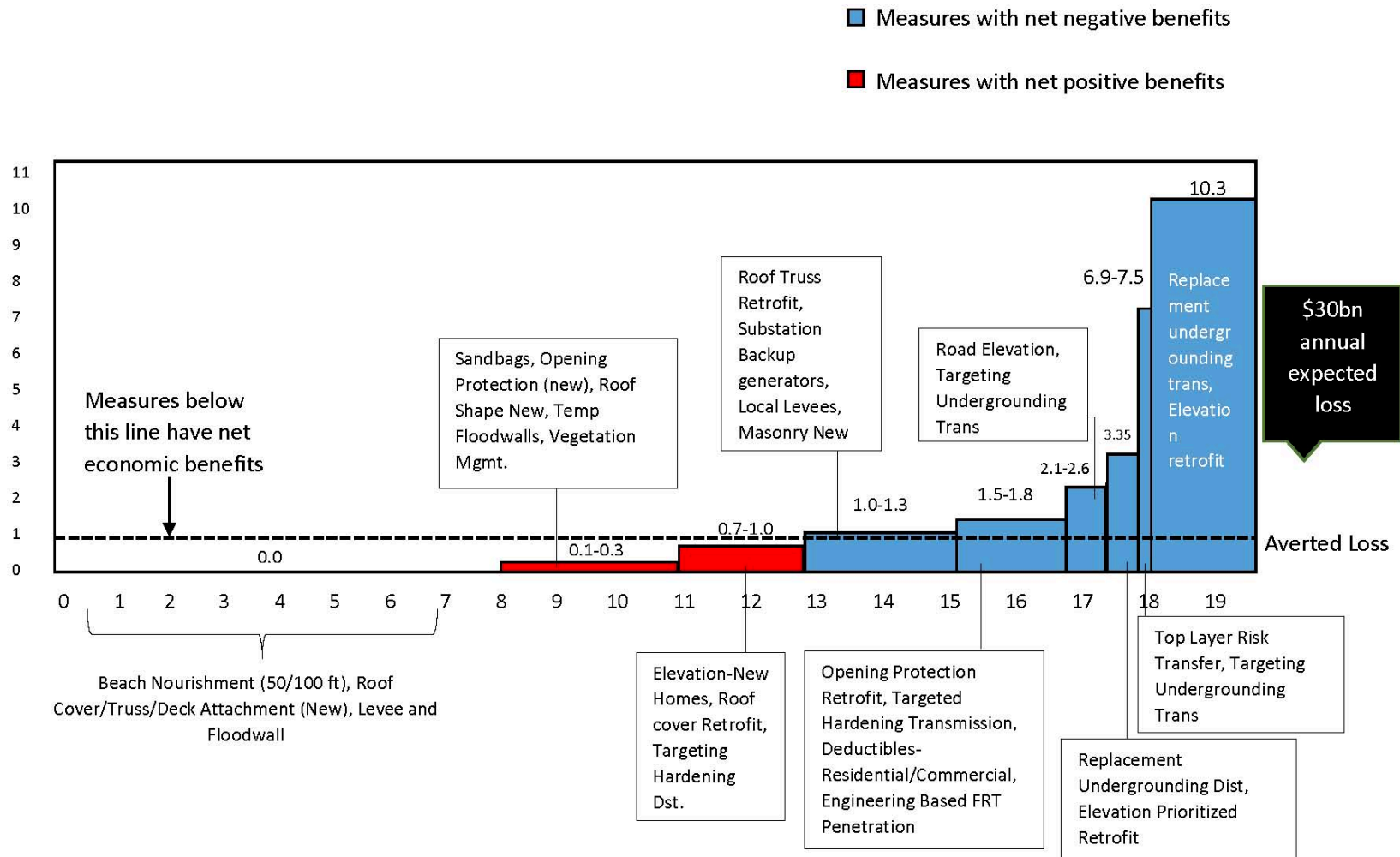


Of the 50 states, Florida is the most vulnerable to rising sea levels, standing just a few feet above the current level. Miami is in an especially dangerous position because of its porous limestone foundation.

Source: http://www.nytimes.com/interactive/2014/03/27/world/climate-rising-seas.html?_r=1

“Low Regrets” Adaptation Options: Adapting to Sea Level Rise in Florida

10

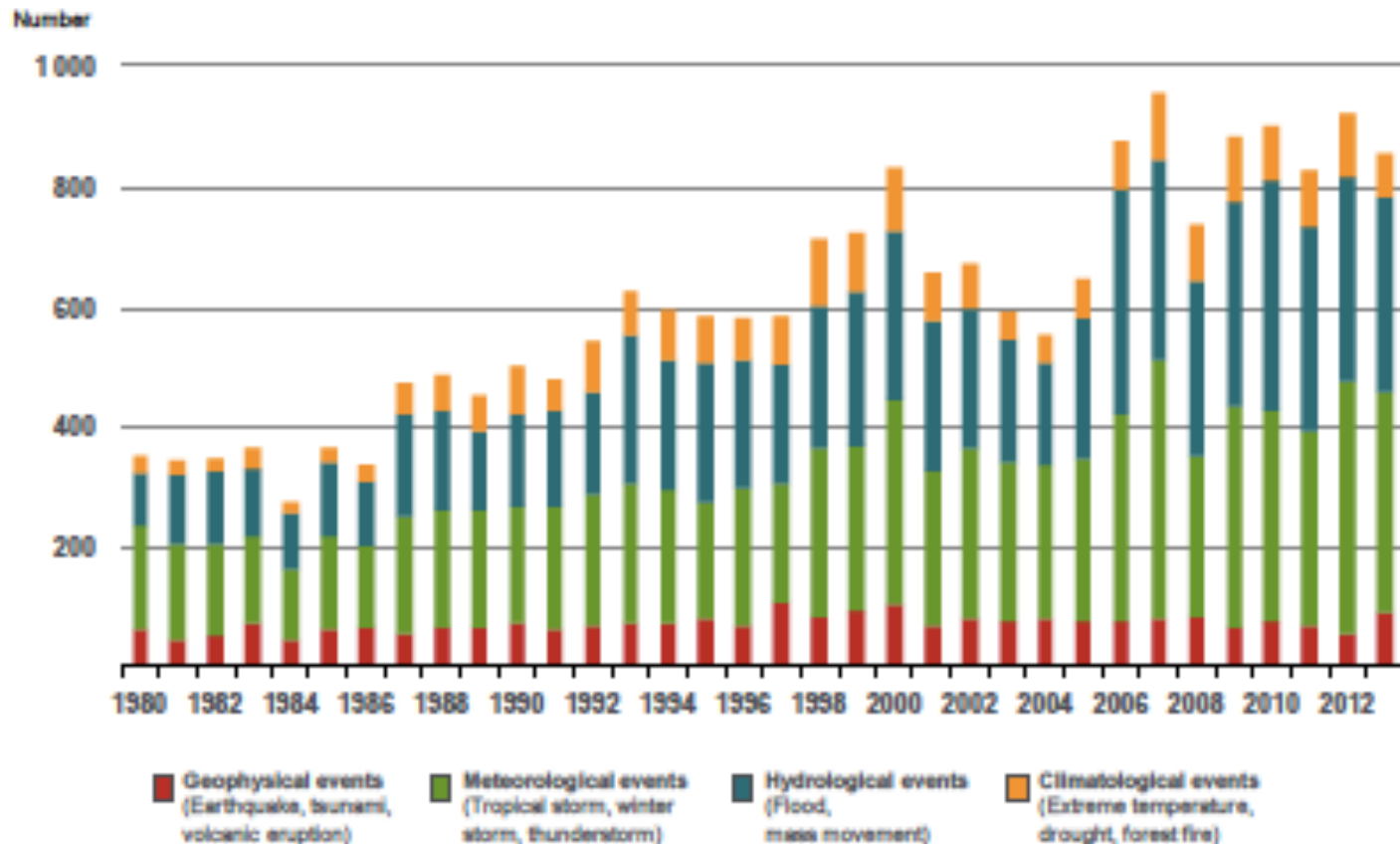


Source: Redrawn from *The Economics of Climate Adaptation Working Group. 2009. Shaping Climate Resilient Development.*

Natural Catastrophes are Increasing in Frequency, Magnitude & Cost

11

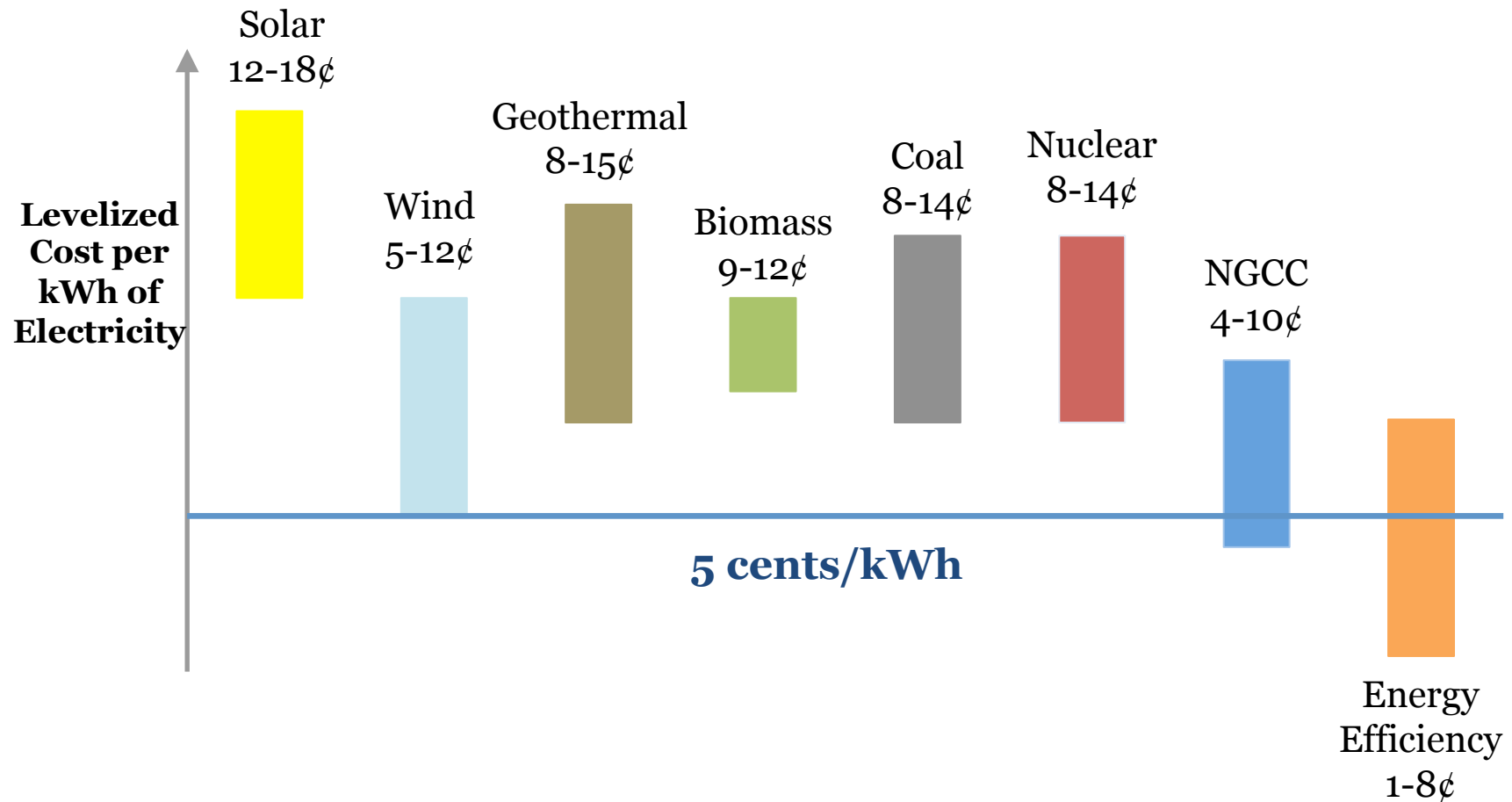
- Global Natural Catastrophes 1980-2013



Source: Munich RE, 2014, *2013 Natural Catastrophe Year in Review*.

How Can the U.S. Mitigate Climate Change: Energy Efficiency is the Least Cost Solution

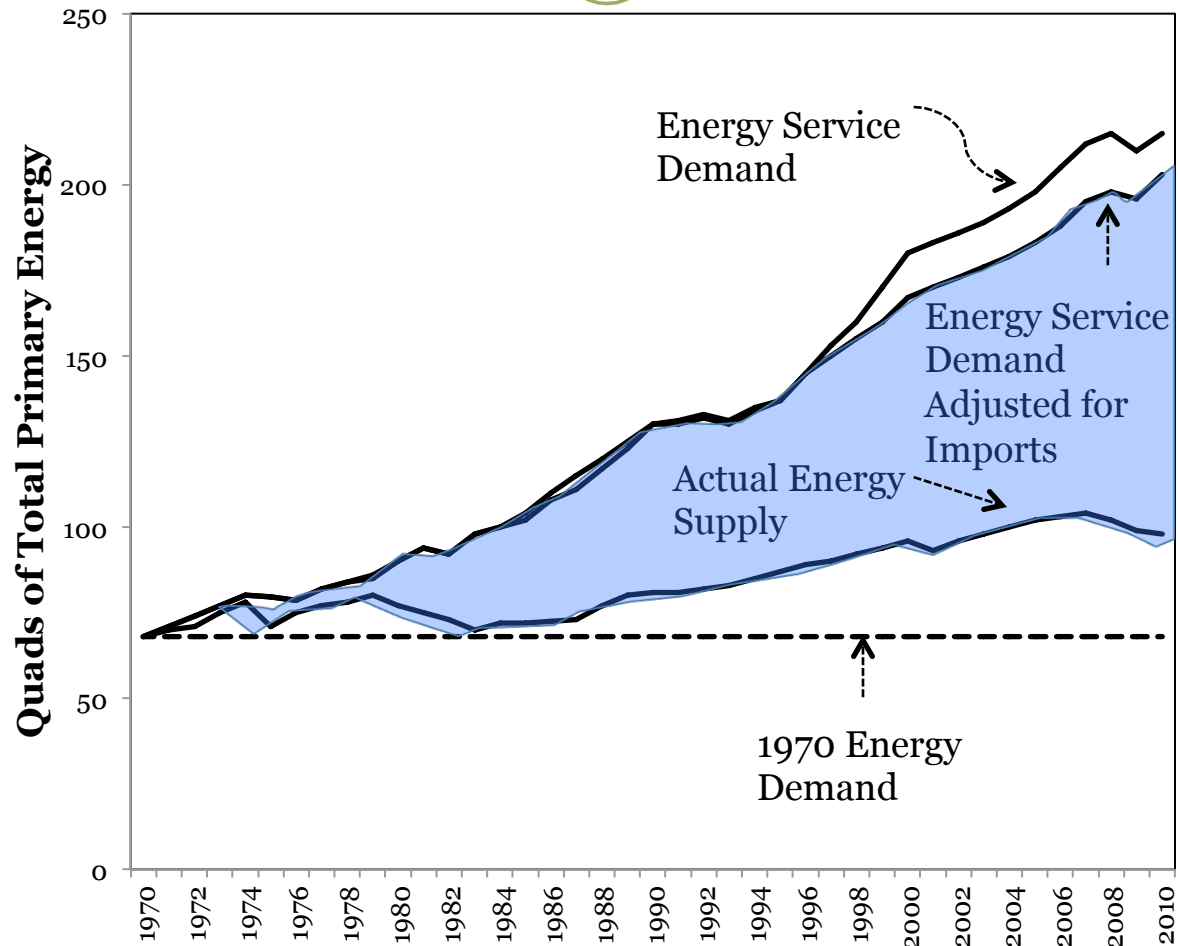
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Yu Wang (2014) "U.S. Electricity End-Use Efficiency: Policy Innovation and Potential Assessment," Dissertation, Georgia Tech.
Data: Sustainable Energy in America 2014 Factbook, Bloomberg New Energy Finance.

Energy Efficiency: The Most Important Fuel, But Overlooked & Underappreciated

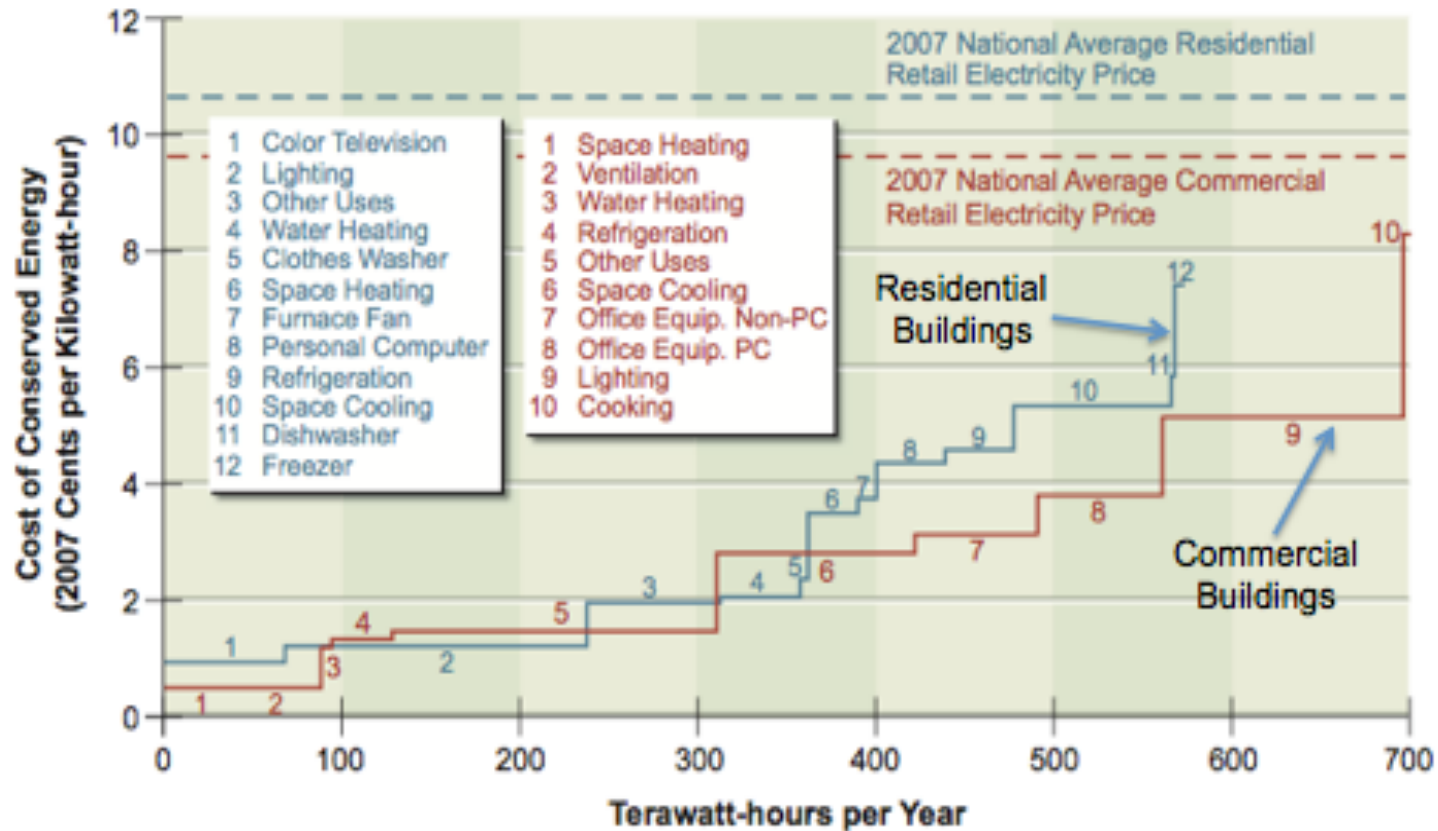
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Source: Adapted from Skip Laitner & Steve Nadel, ACEEE, 2012.

Is Energy Efficiency “Tapped Out?”

14



Cost of Conserved Energy = the additional cost that must be invested to implement energy-savings.

Source: National Academy of Sciences. 2009. *America's Energy Future*.

You Can't Manage what you Can't Measure

15

Many meters provide frequent data collection and bi-directional communication:

- ✓ Enables dynamic pricing
- ✓ Can interface with in-home or in-office displays of online consumption data
- ✓ + Home video monitoring

Energy Orbs signal expensive & inexpensive times to use energy

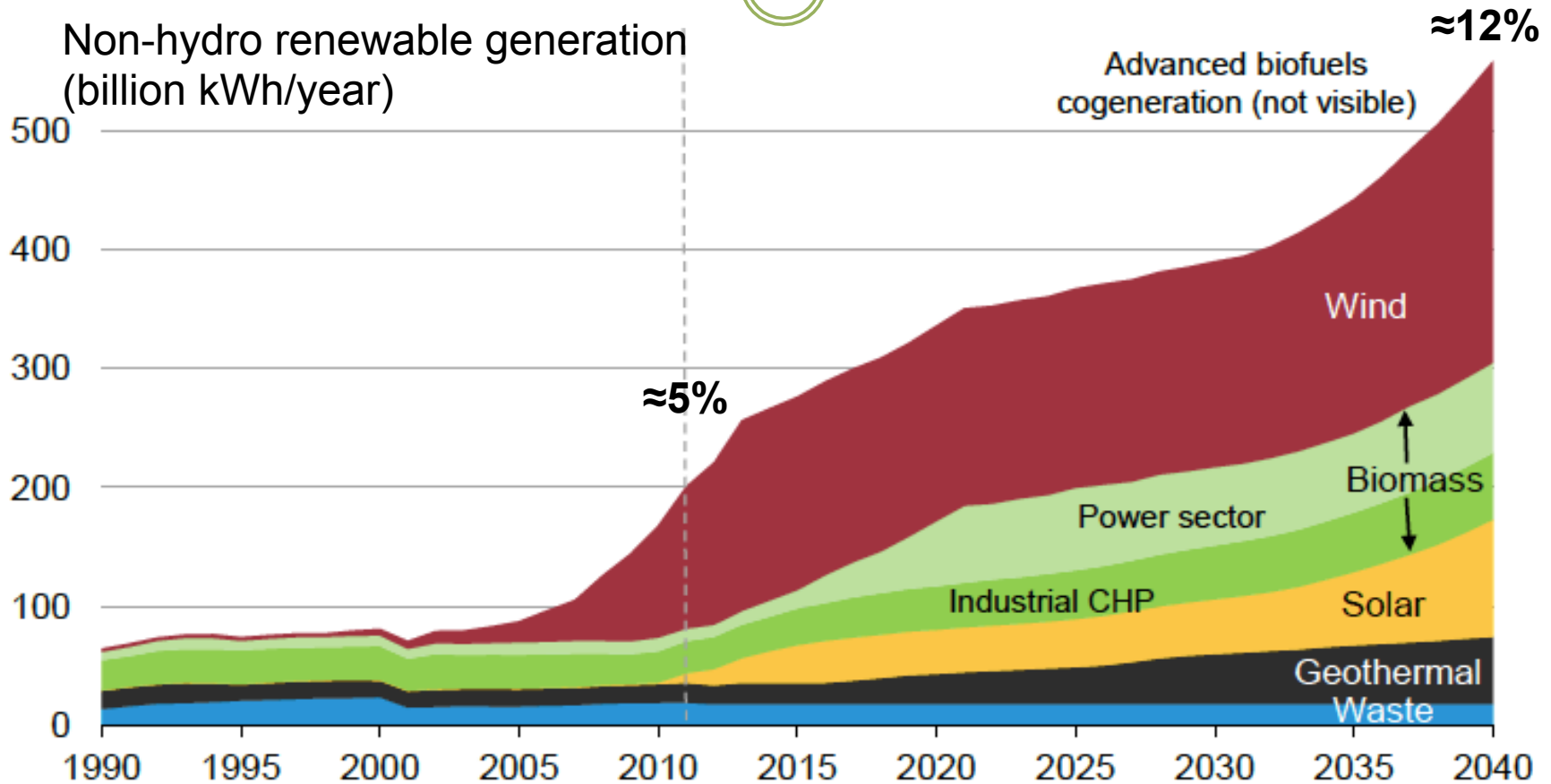


Google/Nest thermostat



The US Green Economy is Progressing, But it Has Been Slowed by the Natural Gas Boom

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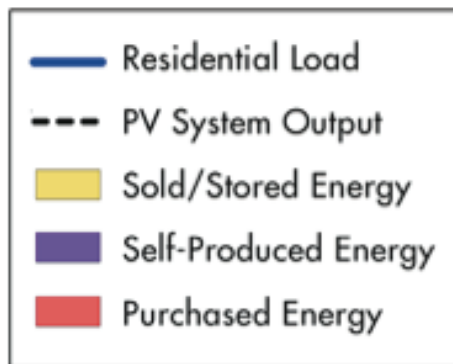
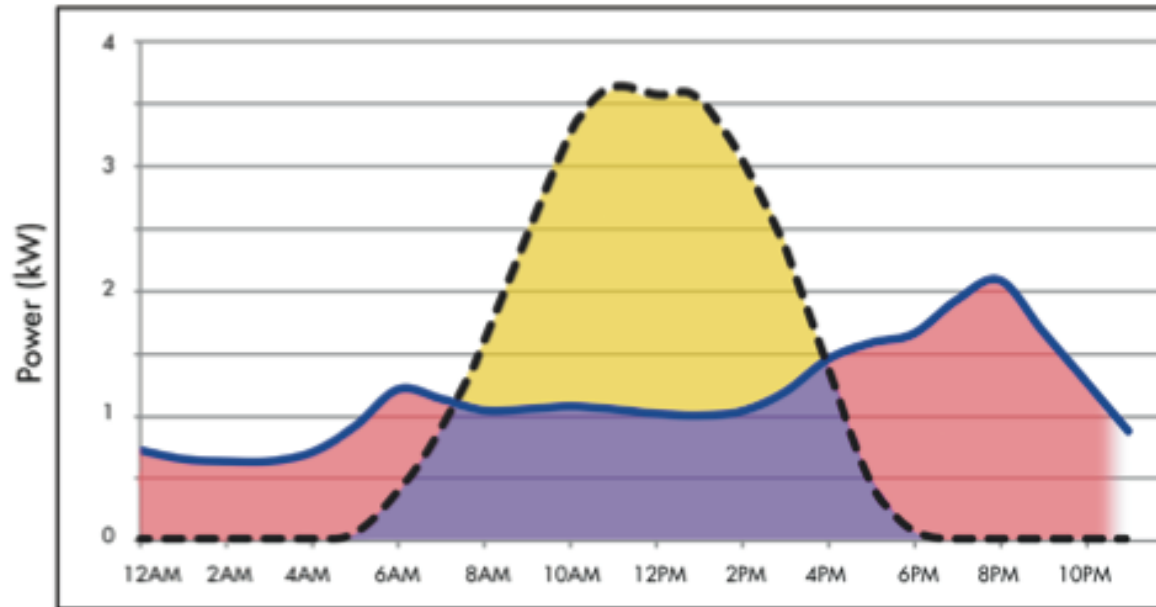


EIA forecasts that non-hydro renewable generation will triple by 2040, with wind, biomass, and solar dominating.

Source: EIA, 2013

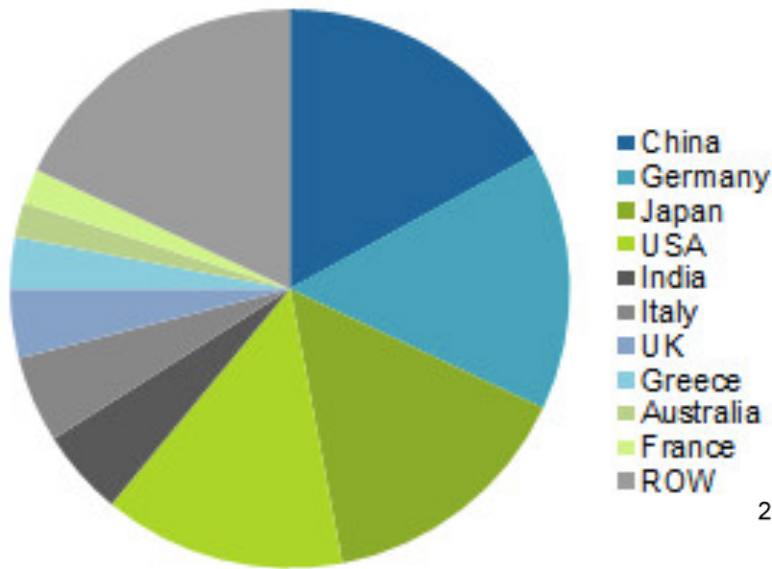
A Challenge for the Grid: Demand & PV System Output are not Coincident

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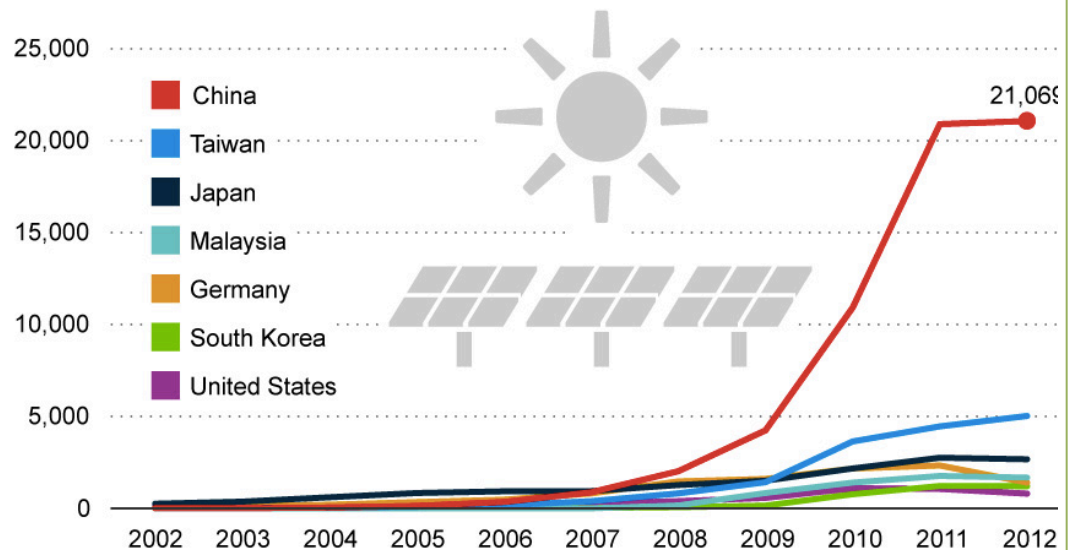
Source: Electric Power Research Institute. 2014. *The Integrated Grid*

While the U.S. is a Major Solar PV Consumer, China Dominates Solar Photovoltaic Production



Consumption: Top 10 PV Markets in 2013

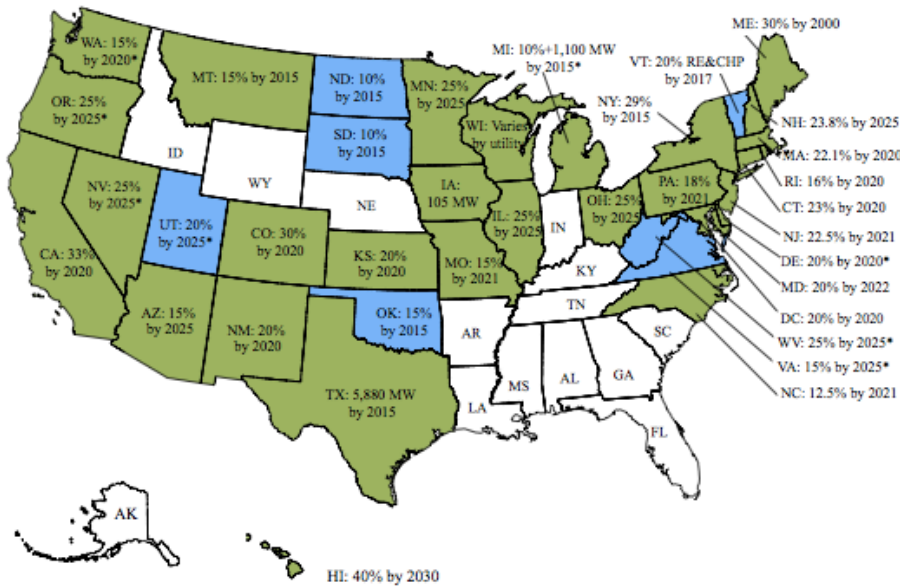
Production of Solar PV Panels: in MW



Few Southern States have Strong RE or EE Policies

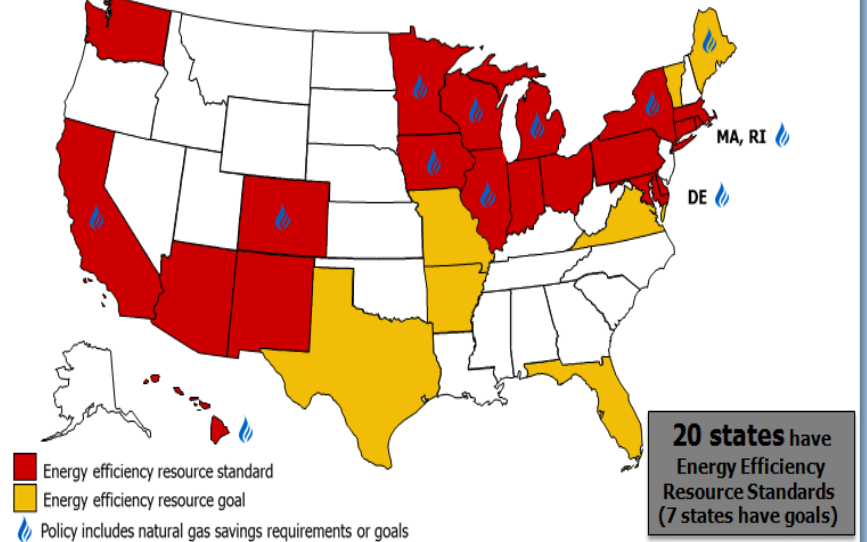
9 Southern States Do Not Have an RPS

9 Southern States Do Not Have an EERS



Energy Efficiency Resource Standards

www.dsireusa.org / October 2012



■ Has State Renewable Portfolio Standard
 No Renewable Portfolio Standard or Goal
■ Has State Renewable Portfolio Goal
 * : Extra credit for solar or customer-sited renewables

RPS=Renewable Portfolio Standard

EERS=Energy Efficiency Resource Standard

TVA's Carbon Success Story

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- TVA has already exceeded the 2020 Climate Action Plan's goal of reducing CO₂ emissions by 17% relative to 2005. TVA's 2013 carbon emissions were >30 percent below 2005 levels.
- Coal plant retirements have been enabled by: the recent recession and curtailed load growth, many unscrubbed coal plants while EPA regs are getting tighter, affordable natural gas, and a new nuclear reactor.
- As a result, in 2011 the TVA Board voted to approve the retirement of 18 coal units. More recent decisions commit TVA to more coal retirements in the future. TVA has also ramped up its renewable procurements and its energy efficiency programs over the past decade.

The Power of Local Action

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- **Regulatory Policy**

- TVA has a “dual meter” policy for monitoring and valuing distributed solar power

- **Information Policy**

- TVA’s eScore Program – assessing a home’s efficiency & assisting with retrofits
- Chattanooga Electric Power Board’s system – the most automated power system of its size in the US

- **Financing Policy**

- TVA’s 1100 MW “virtual power plant” (EE&DR) has saved ratepayers \$700M in avoided capital costs

SCORE CARD		Individual eScores
Saving More Energy	● Heating / Cooling Systems	8
	● Water Heating	7
	● Insulation	6
	● Duct Improvements	6
Wasting More Energy	● Air Sealing	4
	● Appliances	3
	● Lighting	2
	● Windows & Doors	2
	● Home Electronics	1

eScore: 6



Grounds for Optimism

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- Clean energy technologies are improving
 - ✦ renewable markets are growing
 - ✦ the “double dividend” of energy efficiency is expanding.
- Most of the 2050 physical infrastructure is not yet built – with growth comes opportunity
 - ✦ to “lock in” clean energy technologies
 - ✦ to “climate proof” systems whenever infrastructure investments are being made.

For More Information

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